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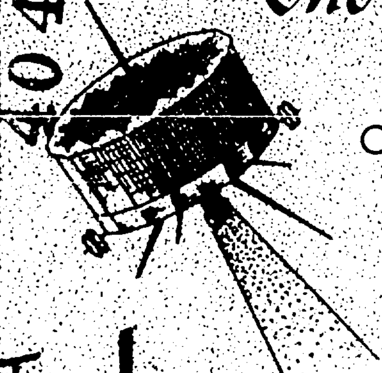

The A. & M. College of Texas

Department of

OCEANOGRAPHY AND METEOROLOGY

Research Conducted through the

Texas A & M Research Foundation

COLLEGE STATION, TEXAS

THE TEXAS DEW POINT FRONT AS SEEN BY TIROS I

SCIENTIFIC REPORT NO. 3

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Project 6698—Task 66982

A & M Project 285—Reference 63-5-T

Walter K. Henry and Aylmer H. Thompson

1 February 1963

Prepared for
Geophysics Research Directorate
Air Force Cambridge Research Laboratories
Office of Aerospace Research
United States Air Force
Bedford, Massachusetts

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ABSTRACT

The general behavior of the West Texas dew point front and the related cloud patterns are described. Several TIROS I pictures of West Texas and the surrounding area were selected for special study; these pictures included also examples when the dew point front was absent. The examples generally showed good agreement between the dew point front and cloud pattern as pictured by the satellite. The match between the cloud patterns and the location of the dew point front was not perfect due partly to the thin layer of moist air near the surface location of the dew point front, and occasionally, higher cloud layers, usually cirrus, which partially masked the location of the dew point front as pictured by the satellite. A few cases occurred where cloud patterns similar to those associated with the dew point front were present, but for which no dew point front was present. Of special interest is a case of "collapse" and "surge" of the dew point front.

The satellite pictures appear to be of potential help in identifying the location of the dew point front particularly in the sparse data areas of western Texas and northern Mexico. The value of such pictures will be greatly improved with the more sophisticated satellites planned in the future. The examples chosen represent spring conditions only. It is felt that summer and fall conditions as pictured by TIROS III, V, and VI should be investigated before conclusions can be considered as definite.

1. Introduction.

The "Dew Point Front," sometimes called the "Marfa Front," is an important weather feature to the forecasters of the southwestern United States and northern Mexico, where this front exists. The position of the front is often closely related to boundaries of the cloud areas and sometimes even of weather areas. Movements of the front result in marked changes in the weather at individual locations. However, the area in which the front exists is a semi-arid and comparatively scarcely populated region, and weather reporting stations are widely spaced, making the front difficult to locate and relate to the forecast.

The objective of this study is to see whether the information provided by the advent of the meteorological satellite systems can furnish additional information on the dew point front. In particular, the attempt was made to:

1. determine if the dew point front may be identified and located more accurately using the TIROS pictures,

2. use the satellite pictures to obtain additional information on the structure and behavior of the dew point front, and

3. establish a tentative operational procedure for using the satellite pictures to locate the dew point front.

2. The dew point front and the air masses involved.

The dew point front (Marfa front) is of local interest. It does not have enough importance to be routinely located on the analyses transmitted over the teletype and facsimile networks by the National Weather Analysis Center. In its own area, however, it marks the limit of morning stratus, is the birthplace of thunderstorms and line squalls, and causes heat waves as it advances eastward. The geographic home of the dew point front includes western Texas, western Oklahoma, New Mexico, Colorado, western Kansas, and the adjacent territory of Mexico. Fig. 1 outlines this area and locates the stations mentioned in this paper.

The front has, in general, a north-south orientation and separates the northward flowing maritime tropical air (mT) coming from the Gulf of Mexico from the continental tropical (cT) air formed to the west over the semi-arid plateaus of the southwestern United States and northern Mexico. The front slopes upward to the east and slightly to the south, in contrast to the terrain, which slopes upward to the west and slightly to the north. The frontal slope

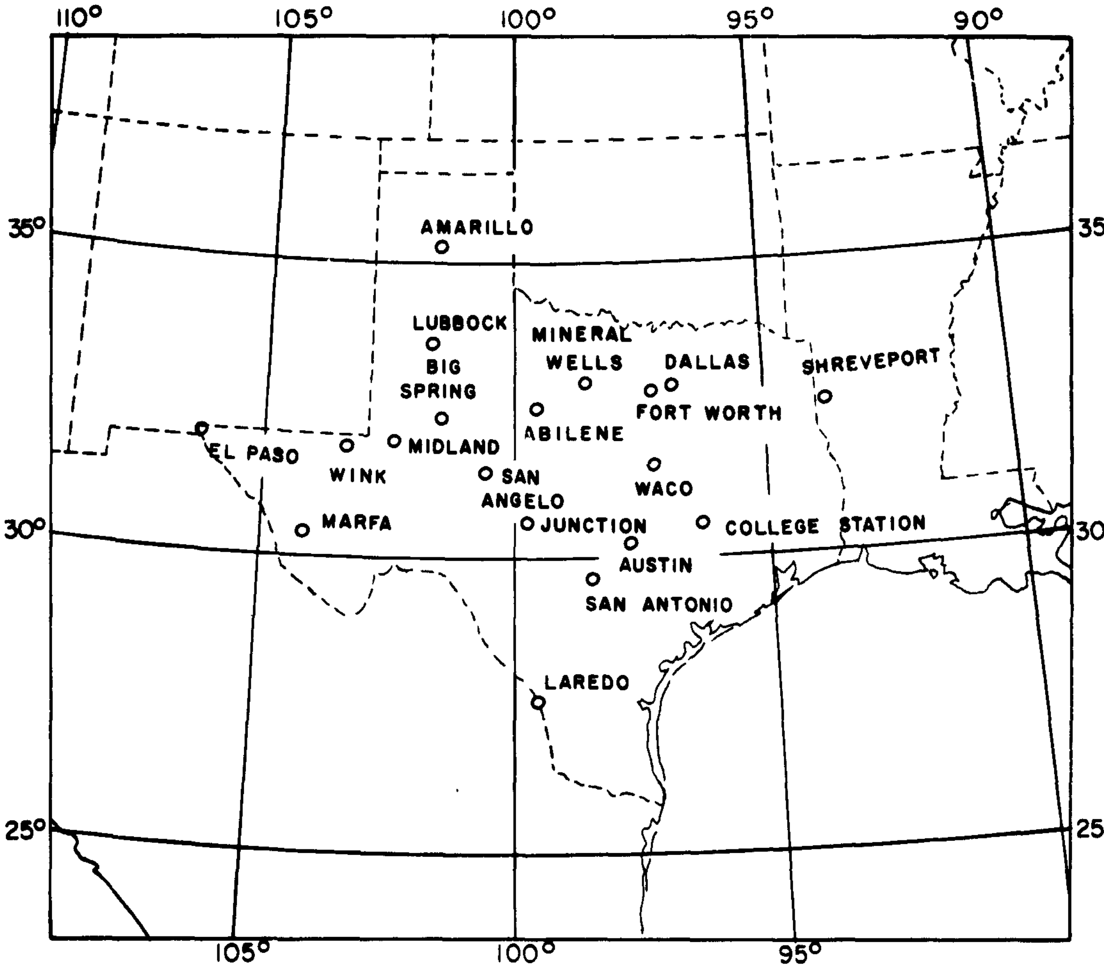


Figure 1. -- Locator map of the geographical area considered in this report.

is comparatively slight; this fact, combined with the opposite slopes of front and terrain result in an appreciable east-west movement of the surface position of the front with a small change in depth of the maritime air below the front. Increasing depth is, of course, associated with westward movement.

Radiosonde data show the vertical separation of the maritime and continental air. A typical sounding for a station in the continental air has a lapse rate which approaches the dry adiabatic lapse rate. It is free of inversions except that the nighttime sounding often shows strong nocturnal cooling in the lowest levels. In the heat of the day the lowest layers (less than 1000 ft) may have a superadiabatic lapse rate. The potential temperature of the sounding is close to 320°A. The dew point curve may show some moisture at the surface, but a few hundred feet from the surface the air is usually too dry for the radiosonde to measure.

In East Texas, where the maritime air is at the surface, the typical 1200Z sounding shows the cooler moist air (potential temperature often below 310°A) of the lower layers with a temperature inversion at about 5,000 ft. Below this inversion, the maritime air is well mixed by the wind turbulence. The nocturnal inversion is not so pronounced and only on rare occasions will the daytime heating destroy the frontal inversion. Below the inversion, the dew point is not much colder than the temperature so fog and the characteristic "Gulf Coast Stratus" easily form. Above the inversion, the air is dry, has a conditionally unstable lapse rate, and a potential temperature of about 320°A; this air is comparable to the continental tropical air on the surface further west. This continental tropical air overrunning the front is often identified as a "superior" air mass by some analysts. However, the air above the inversion does not subside with time, and can be linked to the continental air at the surface to the west of the front.

The wind structure has some variation from day to day but, in general, follows a consistent pattern. In the maritime air, the flow is from the south and southeast as illustrated in Fig. 2. Near the surface west of the dew point front, the flow is from a westerly direction. This flow varies and may be from the northwest through southwest. The surface winds are usually light and variable, but occasionally become quite strong west of the front. The continental flow continues aloft from a westerly direction above the front.

On occasion, the dew point front moves eastward to a surface position in East Texas. Whenever this occurs, the area just west of the front is unusually warm, because not only has the maritime air been replaced by the continental air, but the latter has been additionally warmed by the down slope flow.

A fairly typical and persistent cloud behavior and distribution pattern is associated with the dew point front. During the night, fog and stratus usually

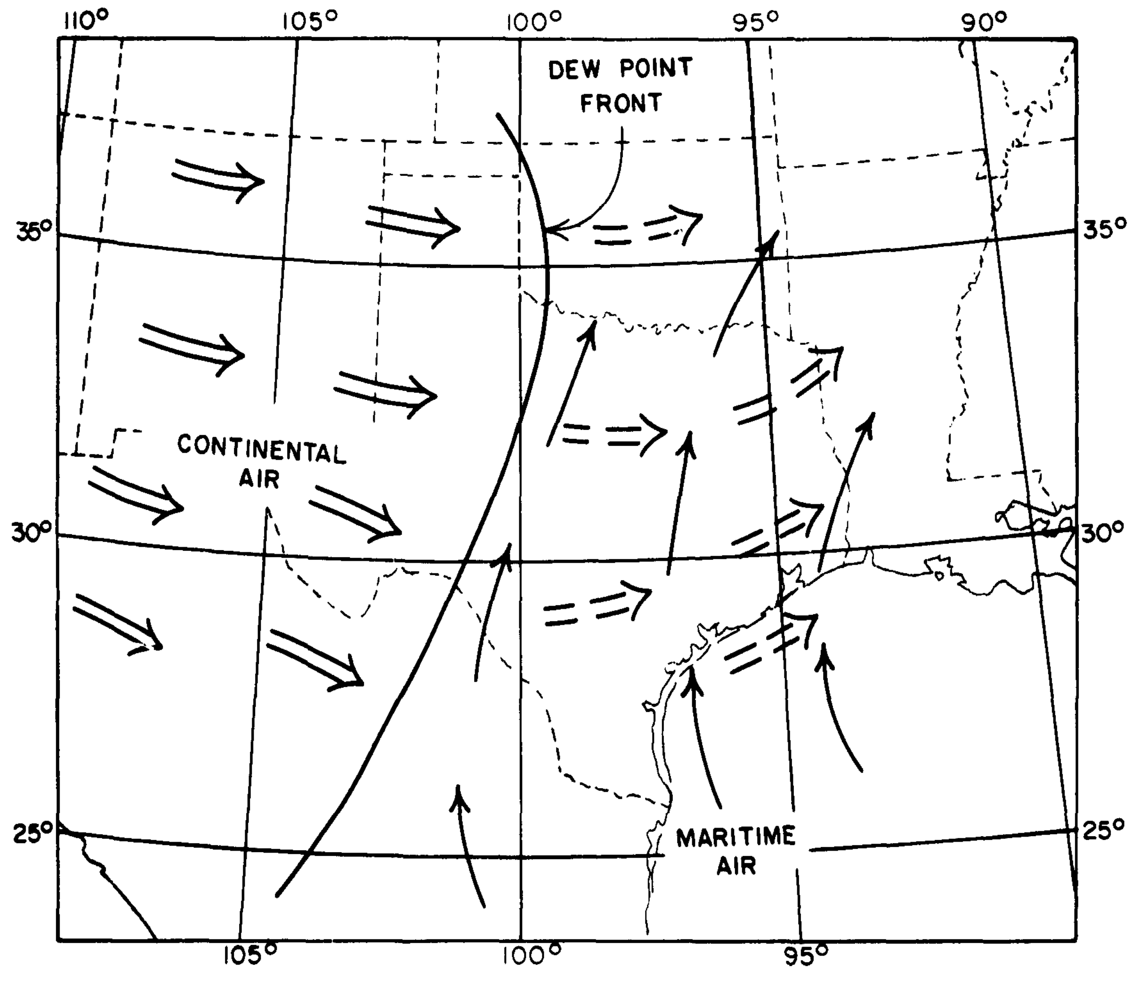


Figure 2. -- A diagram of typical air flow associated with the dew point front. The flow of maritime air near the surface is indicated by the solid single shaft arrows. The surface flow of the continental air is shown by the solid double shaft arrows, while the continuation of the flow of the continental air above the maritime air is shown by the broken double shaft arrows.

form in the maritime air mass and blanket East Texas. In mid-morning, the stratus overcast "burns off" and the cloud cover becomes scattered stratocumulus, or occasionally the clouds dissipate completely. About noon cumulus clouds begin to form, either from the stratocumulus or in the previously clear skies. The future of the cumulus depends upon the strength of the frontal (subsidence) inversion. The cumulus which are unable to break through the inversion are flattened on top and do not develop. Those cumulus cells which break through the inversion usually entrain dry air from the continental air above the inversion so that they become smaller with height. A few sometimes develop into isolated thunderstorms, especially near the coast where the sea breeze effect adds to the convergence.

Lines of thunderstorms sometimes form just to the east of the surface position of the dew point front. This happens when the maritime air undergoes strong convergence just to the east side of the front. This air has already been lifted by blowing upslope. Unless the inversion is strong, the maritime air will break through and a line of thunderstorms will form. These occur in the afternoon and the line will move eastward and dissipate during the night. A surge of the maritime air toward the west is the usual precursor of the formation of such a line of thunderstorms.

Clouds occasionally occur west of the surface position of the dew point front. Sometimes, when the continental air has a component of motion from the east rather than the usual westerly motion, there is sufficient orographic uplift to result in cumulus development over the mountains of western Texas and New Mexico. It is probable that the continental air is more moist than usual when such development occurs. Cirrus clouds also occur west of the dew point front. No attempt is made here to describe the several ways in which such cirrus originate.

3. Analysis objectives and procedure.

Many of the phenomena described in the preceding section are visible phenomena. As such, they should be evident in the photographs obtained from the TIROS I meteorological satellite. In particular, it was anticipated that the pictures might show (a) the extent of the morning stratus, (b) the afternoon cumulus areas within the maritime air mass, (c) the line of thunderstorms just east of the front, and (d) orographic cumulus and possibly cirrus west of the front. The photographing of some of these features depends on the satellite being in the proper place and orientation at a suitable time.

The Catalogue of Meteorological Satellite Data - TIROS I (U. S. Weather Bureau, 1961) was used to locate television pictures showing the area described in Fig. 1. Twelve orbits having suitable pictures were selected. In general, the pictures had nadir angles less than 45°. The appropriate frames of these orbits were oriented and rectified using the methods described by Hubert (1961). The results are subject to the usual rectification and interpretation errors as discussed, for instance, by Erickson and Hubert (1961). When all errors of orientation and location are considered, the cloud position may easily be in error by fifty or so miles. Some orbits may have errors up to two or three degrees of latitude.

For comparison with the cloud patterns pictured by television, surface and upper air data were plotted and analyzed using conventional analysis methods. The surface position of the dew point front was sometimes hard to locate within fifty miles because of the distance between reporting stations. Also, the clouds in the maritime air did not extend to the boundary of the maritime air. On its western edge the maritime air was so shallow it could not be lifted to its condensation level because it was stopped by the inversion. In some cases, the clouds in the maritime air were hidden because of higher clouds. These cloud layers were often hard to separate. Because of these problems, exact alignment between the clouds and the front would not be expected.

4. Some examples.

This section presents details of the study of the selected satellite pictures and the corresponding conventional information. The results are first presented in summary form in Table I. The individual pictures are then considered in detail. The discussion is arranged according to the kind of feature shown by the example.

The dew point front ordinarily is a summer phenomenon and is sometimes not evident until well along in the spring. Orbits 91 and 105 were made in early April of 1960, and the appropriate air mass contrasts for existence of the front were not yet present. Neither cloud patterns nor synoptic maps showed any indications of the dew point front.

Table I. --The orbits studied and a summary of the comparison of the cloud pictures and the analyzed maps.

ORBIT	FRAME NUMBER	DATE	TIME (Z)	DEW POINT FRONT ANALYZED ON MAP	TIROS I PICTURE INDICATES FRONT	PICTURE AND MAP CONCUR
91	6	7 Apr	1836	No	No	Yes
105	8	8 Apr	1747	No	No	Yes
119	2	9 Apr	1654	No	Yes	No-clouds show pattern
630	3	14 May	2056	Yes	Yes	Yes-good agreement
659	4	16 May	2036	Yes	No	No
673	9	17 May	2002	Yes	Yes	Yes-good agreement
687	3	18 May	1909	Yes	Yes	Yes-after adjustment
702	3	19 May	1958	Yes	Yes	Yes-high nadir angle
863	6	30 May	2225	No	No	Yes
920	1	3 Jun	2037	Yes	Yes	Yes
949	5	5 Jun	2035	Yes	Yes	Yes-good agreement
992	9	8 Jun	1941	Yes	Yes	Yes-not good-60° nadir angle

Case 1. --Dew point front not present but TIROS picture suggests suitable cloud pattern.

Orbit 119 on the 9th of April had a cloud picture in which the cloud patterns appeared to fit the preconceived concept of how the dew point front would appear. However, the front was between tropical maritime and polar continental air masses and hence was not the dew point front. The clouds were in the maritime air mass and the clear area was in a polar air mass. This orbit is discussed by Randerson (1962). This example demonstrated that a picture may show a cloud pattern which, unless care is taken, can be interpreted to represent a condition which does not exist.

Case 2. --Dew point front present and TIROS I pictures indicate a front.

A picture taken by TIROS I (Orbit 630) on the 14th of May provides an excellent example of the dew point front cloud pattern. At this time, a polar front with cold air to the north extended from Kansas through the Texas Panhandle and westward (see Fig. 3). The dew point front was active and well marked. It was a moving front, as indicated by the dew point and wind changes shown in Table II. The dew point front passed Abilene and San Angelo between 1800Z and 2100Z. It was already east of Big Spring by 1800Z and had not passed Junction and Mineral Wells by 2100Z.

Table II. --The 1800Z and 2100Z temperature and dew point reports from selected stations, 14 May 1960.

STATION	TIME	WIND	TEMPERATURE	DEW POINT
Abilene	1800Z	S 10 kts	96 F	53 F
	2100	W 4	103	33
San Angelo	1800	W 4	91	60
	2100	W 10	105	29
Junction	1800	W 4	91	60
	2100	Calm	100	52
Mineral Wells	1800	S 20	84	65
	2100	S 10 + 18	91	65
Big Spring	1800	NW 10 + 20	98	34
	2100	W 15	101	30

Early in the day, before solar heating became effective, the stratus had extended almost to the surface position of the dew point front. By mid-afternoon, as the dew point front moved eastward, the maritime air had become comparatively shallow over Junction and Mineral Wells, and the clouds had dissipated completely in that area. The condensation level for the surface air was more than 5,000 ft above the surface, but the maritime air mass layer was only about 2,000 ft deep. The result was a clear zone east of the surface position of the front. While the density of stations does not permit exact location of the edge of the cloud layer from the nephanalysis, a fairly good approximation can be obtained from the data. The western edge of the stratus layer at 2100Z is shown in Fig. 3. (Reproduction limitations prevented replotting in Fig. 3 of all stations used in the analysis.)

An idea of the cloud distribution in the vertical is presented in Fig. 4, a vertical cross section from El Paso to Shreveport, Louisiana, for 2100Z on the 14th. This diagram shows the position and slope of the dew point front as well as schematic distribution of the clouds, based on the surface reports.

The wind structure some three hours later along the same line is diagrammed in Fig. 5. Note the southerly winds in the maritime air and the westerly winds above the dew point front. The type of wind distribution illustrated by the Fort Worth sounding is also indicated by the San Antonio sounding, taken some 230 miles to the south-southwest (shown on the right side of Fig. 5), suggesting some tendency for north-south uniformity.

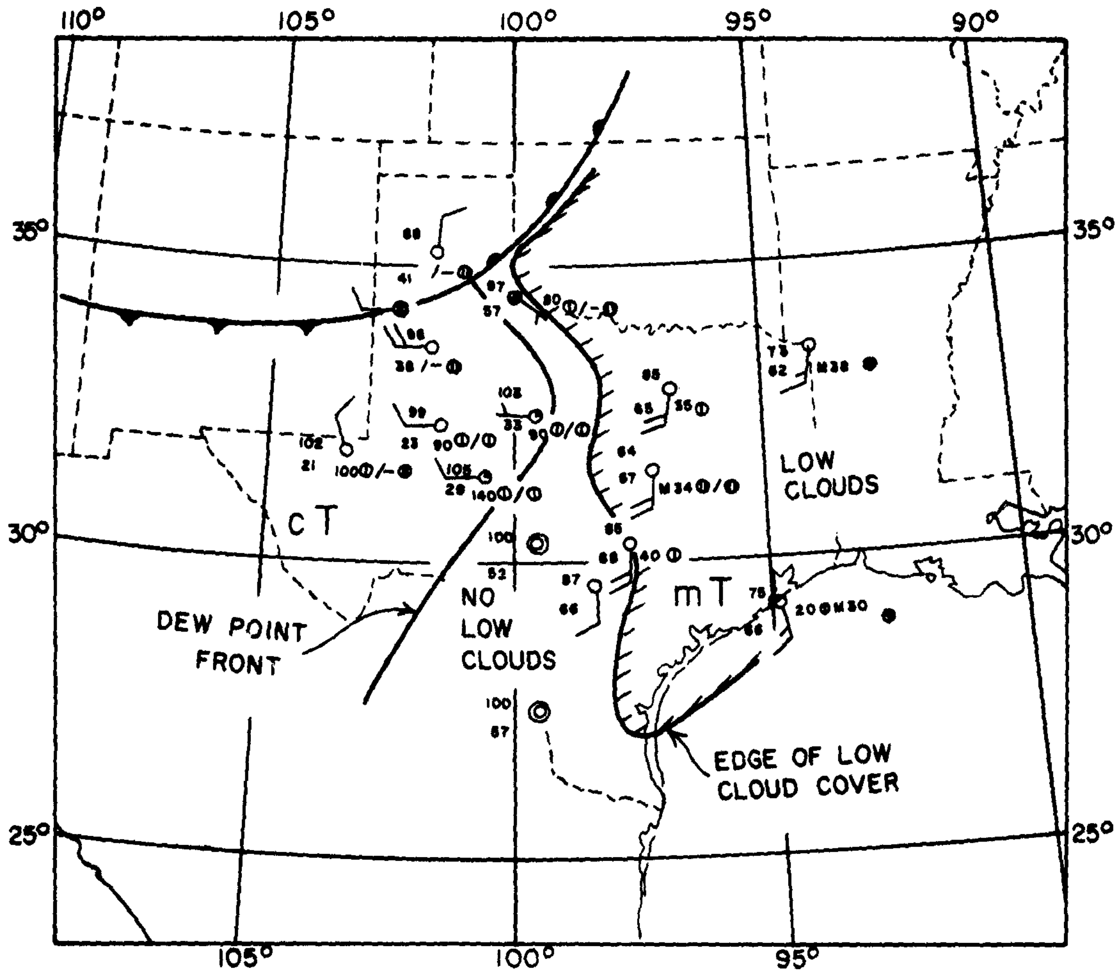


Figure 3. -- The location of the dew point front, 14 May 1960 at 2100Z. The dew point difference and wind shifts across the front are clearly shown. The edge of the clouds analyzed by surface reports is shown by / / / / / / / / / /. Selected data are plotted.

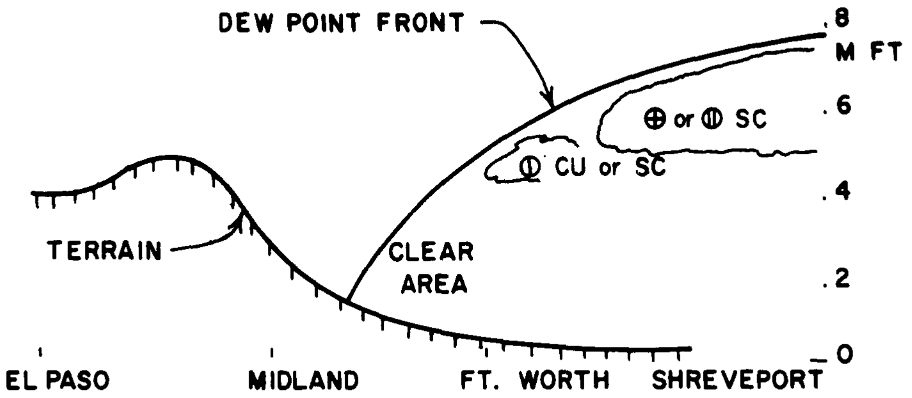


Figure 4. -- A cross section from El Paso to Shreveport, 14 May 1960 at 2100Z, illustrating the vertical extent of the dew point front and the clouds. The expanded vertical scale makes the front appear to slope more than it really does.

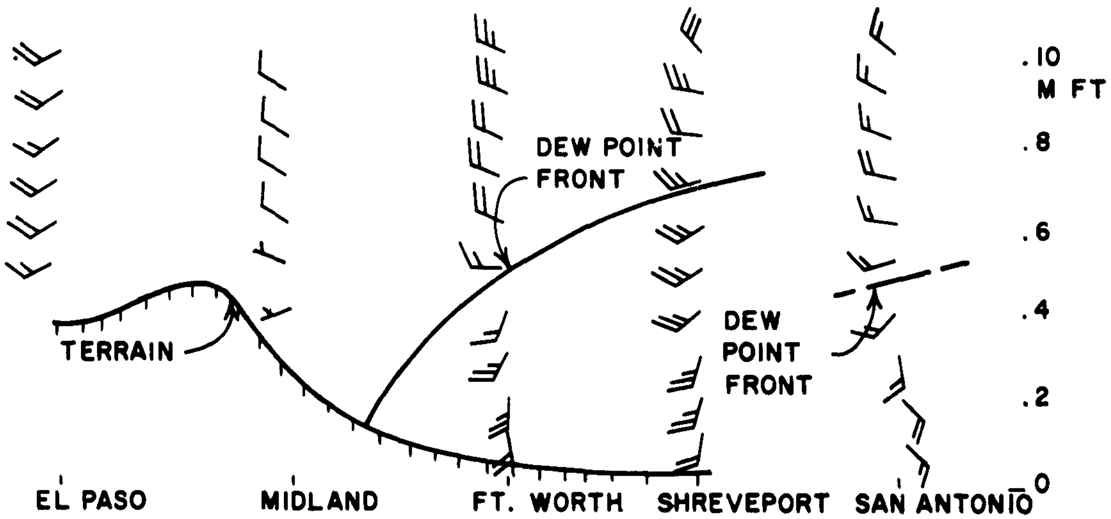


Figure 5. -- Cross section from El Paso to Shreveport showing the winds at every thousand feet and the location of the dew point front, 15 May 1960 at 0000Z. The winds at San Antonio, some 230 miles SSW of Fort Worth, are indicated at the right.

The dew point front locations in Figs. 4 and 5 are based not only on the wind observations but also on radiosonde observations. The soundings used are plotted in Fig. 6. El Paso and Midland are in the continental air from the surface up, while the other three stations clearly have surface layers of maritime air. The depth of the maritime air can be clearly seen at each station. The depth is about the same at Fort Worth and at San Antonio while the maritime air is somewhat deeper at Shreveport. The air above the inversion at these three stations is quite similar to the air at the corresponding levels above El Paso and Midland. Note that all stations have about the same potential temperature and a lapse rate, approaching the dry adiabatic lapse above the inversion if it exists, or above the ground if no inversion exists.

Frame 2 of Orbit 630 of TIROS I was taken at 2056Z on 14 May 1960. This frame corresponds almost exactly in both time and area with the information pictured in Fig. 3. Fig. 7a is a reproduction of the television photograph, while Fig. 7b is a rectified diagram of the cloud coverage sketched on a map corresponding to Fig. 3. Both the dense stratocumulus cloud mass east of the dew point front and the scattered low clouds and scattered to broken high clouds west of the dew point front show up quite nicely in the TIROS picture.

A comparison of the nephanalysis of Fig. 3 and the cloud pattern of Fig. 7 can be seen in Fig. 8. This figure also includes the locations of the surface fronts. The line marking the western edge of the stratiform clouds as determined by the surface reports coincides fairly well with the western edge of the dense stratocumulus cloud mass pictured by the TIROS satellite. Some of the discrepancy is certainly due to low'density of surface observing stations, while part may well be due also to the inaccurate location and rectification of the satellite picture. The picture does show details of small breaks and protuberances that the nephanalysis cannot reveal. Neither cloud boundary extends westward to the front for the reasons already discussed.

In summary, it may be stated that this case illustrated quite well the structure of the dew point front. The orientation of clouds relative to this front, and in particular the cloud free area just to the east of the dew point front, were quite clearly shown. The TIROS I cloud photographs were certainly clearly able to show the cloud coverage of the area. Indeed, a definite improvement of cloud cover presentation over a conventional nephanalysis could be obtained from the detailed distribution of the clouds pictured on the satellite photograph.

Although the dew point front was moving on the 14th, by evening it had become almost stationary and remained so for at least a couple of days. On the 15th, the TIROS I satellite did not take any suitable pictures of the area.

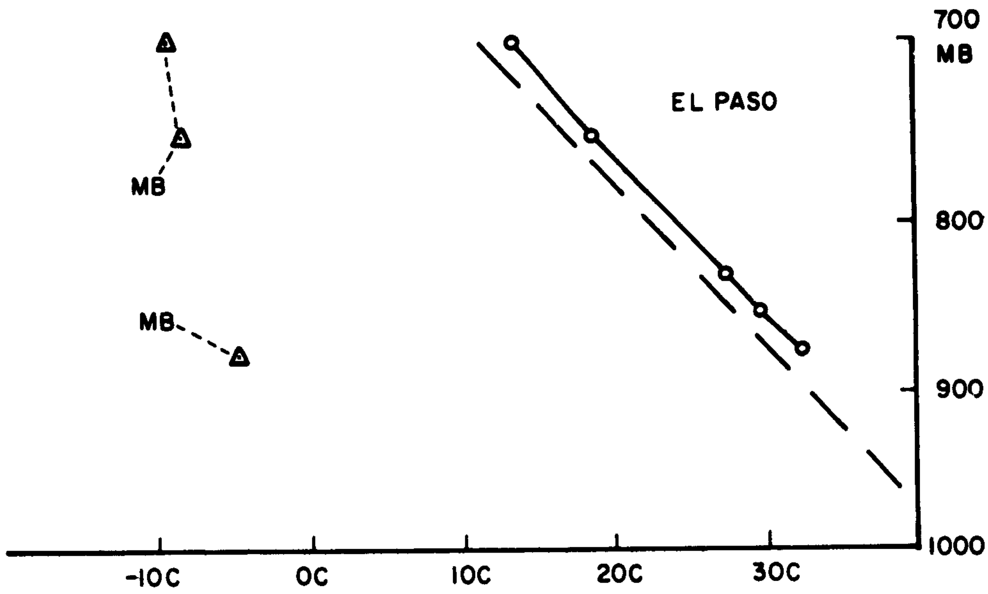


Figure 6a. -- Radiosonde data for El Paso, 15 May 1960 at 0000Z, plotted on a pseudo-adiabatic chart. The solid line is temperature, the dotted line is dew point, and the dashed line the 315°A potential temperature line.

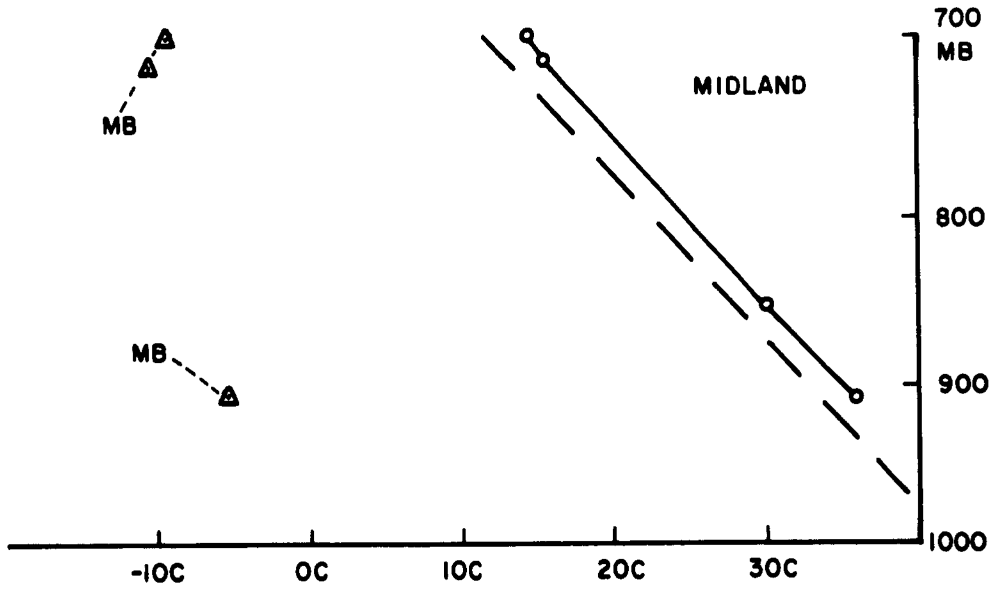


Figure 6b. -- Radiosonde data for Midland, 15 May 1960 at 0000Z, plotted on a pseudo-adiabatic chart. The solid line is temperature, the dotted line is dew point, and the dashed line the 315°A potential temperature line.

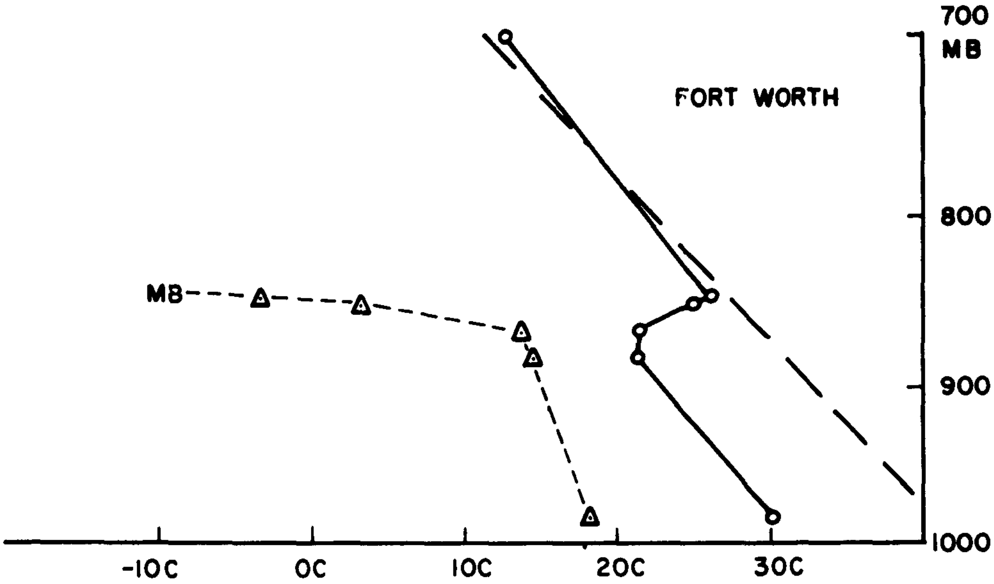


Figure 6c. -- Radiosonde data for Fort Worth, 15 May 1960 at 0000Z, plotted on a pseudo-adiabatic chart. The solid line is temperature, the dotted line is dew point, and the dashed line the 315°A potential temperature line.

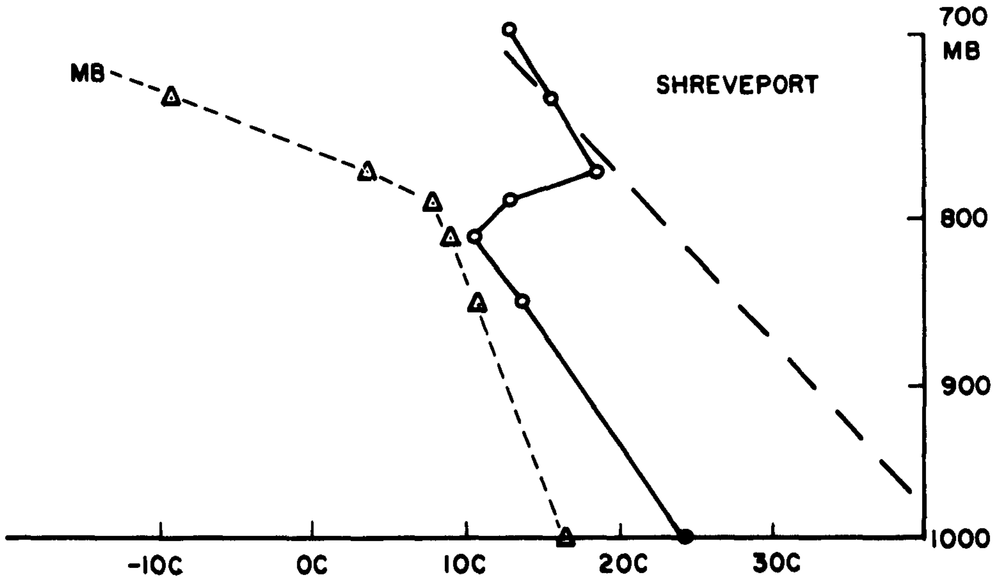


Figure 6d. -- Radiosonde data for Shreveport, 15 May 1960 at 0000Z, plotted on a pseudo-adiabatic chart. The solid line is temperature, the dotted line is dew point, and the dashed line the 315°A potential temperature line.

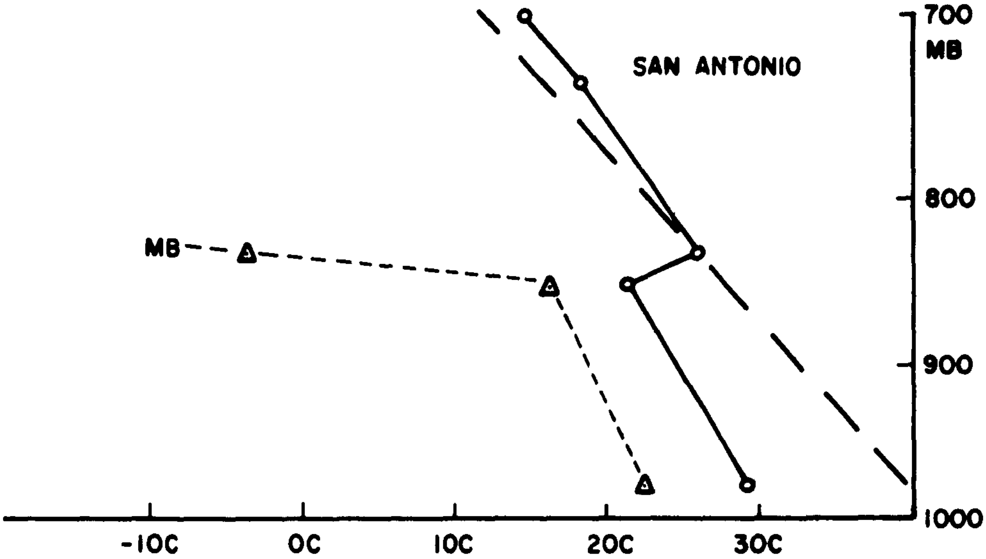
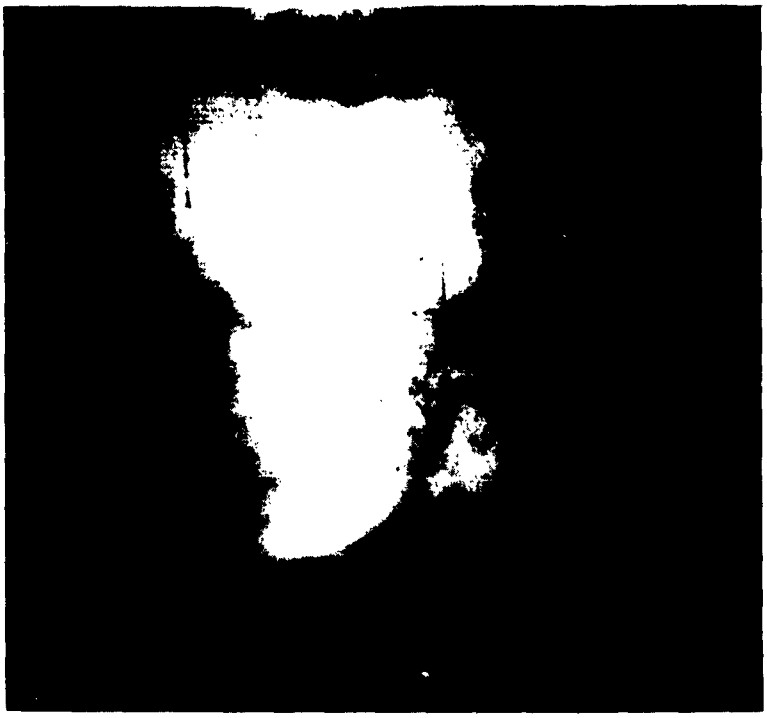


Figure 6e. -- Radiosonde data for San Antonio, 15 May 1960 at 0000Z, plotted on a pseudo-adiabatic chart. The solid line is temperature, the dotted line is dew point, and the dashed line the 315°A potential temperature line.



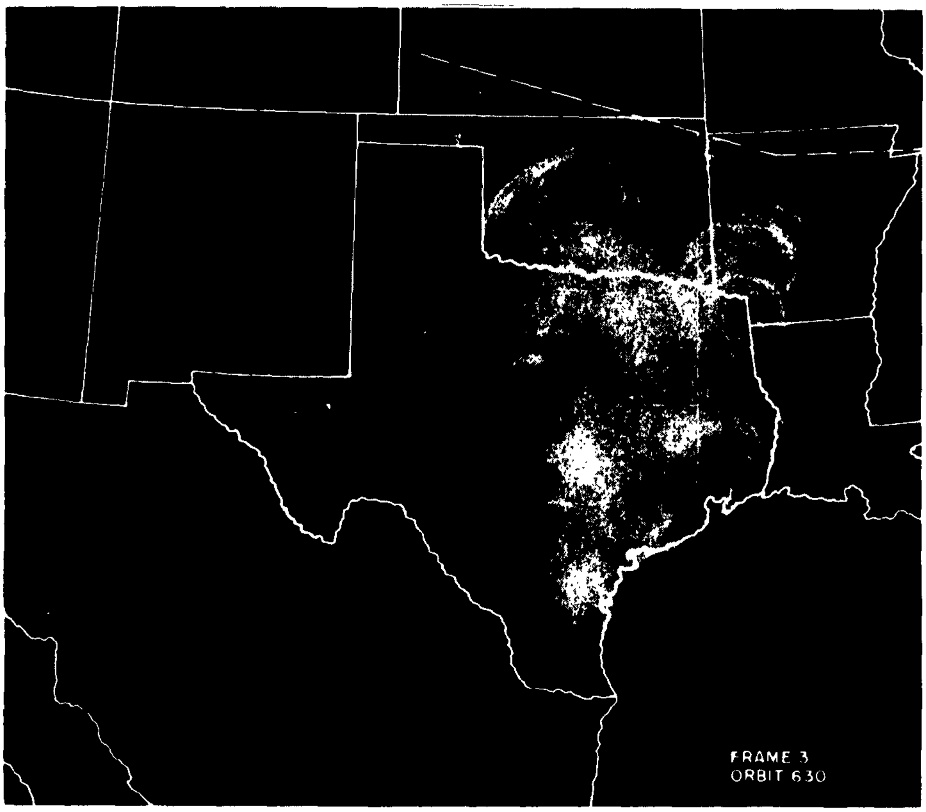


Figure 7a. -- Orbit 630, frame 3, 14 May 1960 at 2056Z.
Figure 7b. -- A rectified schematic diagram of the clouds pictured by orbit 630, frame 3, 14 May 1960 at 2056Z.

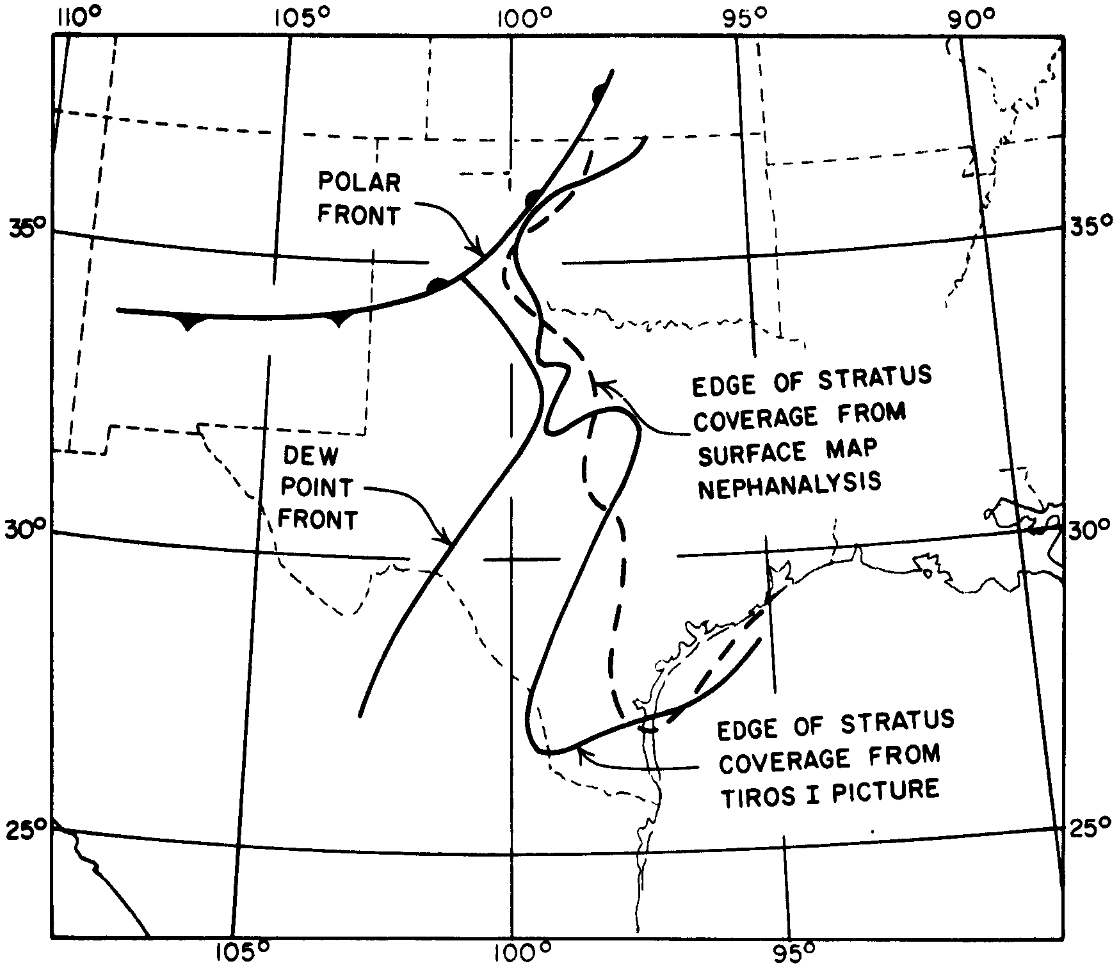


Figure 8. -- A comparison of the nephanalysis from Figure 3, shown as a dashed line, 14 May 1960 at 2100Z, and the cloud distributions from orbit 630, frame 3, shown by the solid line. The surface frontal positions are indicated.

Case 3. --The front existed but the TIROS pictures did not indicate appropriate cloud distribution.

On 16 May, the surface position of the dew point front was approximately the same as on the 14th and 15th. The TIROS I pictures taken on Orbit 659 show the area around the dew point front. This orbit has been studied in detail (Whitney, 1961), but his emphasis was on the area to the northeast of Texas. Figs. 9a and 9b show a reproduction of the satellite photograph and the schematic rectified cloud distribution based on the photograph respectively. Fig. 10 is a synoptic map of the area corresponding approximately to the time of the satellite photograph.

The dew point front was quite clearly evident in western Texas as indicated by the temperature and dew point observations on the surface map for 2100Z on the 16th. By that time the polar front had pushed a little further southward and the associated trough had intensified slightly. The winds within the maritime air mass had turned from southeast to more southwesterly so that the maritime air was moving eastward. Compare the data for the 16th in Fig. 11 with the wind data of Fig. 4, particularly the San Antonio winds. As the wind shifted, the maritime air became more shallow. The subsiding effect of the dew point front, along with the downslope effect of the air moving toward the northeast apparently suppressed cloud formation over eastern Texas. Most stations reported only scattered cumulus and scattered cirrus clouds. These were not even large enough or dense enough to show well in Fig. 9. However, the cloud pattern over Oklahoma and the cumulus developments over Colorado, northeast New Mexico, and the extreme northern Texas Panhandle show up well. These, of course, are not associated with the dew point front. Also, the cirrus clouds over the central Rio Grande Valley show up fairly well.

In summary, it appears that the distribution of cloudiness associated with the dew point front is certainly not a function of the position of the front alone. There is some indication that the cloudiness may depend upon the rate of change of depth of the maritime air. This rate of change of depth may or may not be related to movement of the surface position of the dew point front. The meteorological satellite pictures obviously cannot identify a front which does not have a cloud pattern.

Case 4. --The westward "surge" of the dew point front.

The next day, 17 May, the maritime air surged westward and its depth increased. This surge was accompanied by a backing of the low level winds to the southeast, as shown by the time section for San Antonio (Fig. 11). The increasing height of the dew point front is also shown. The height was

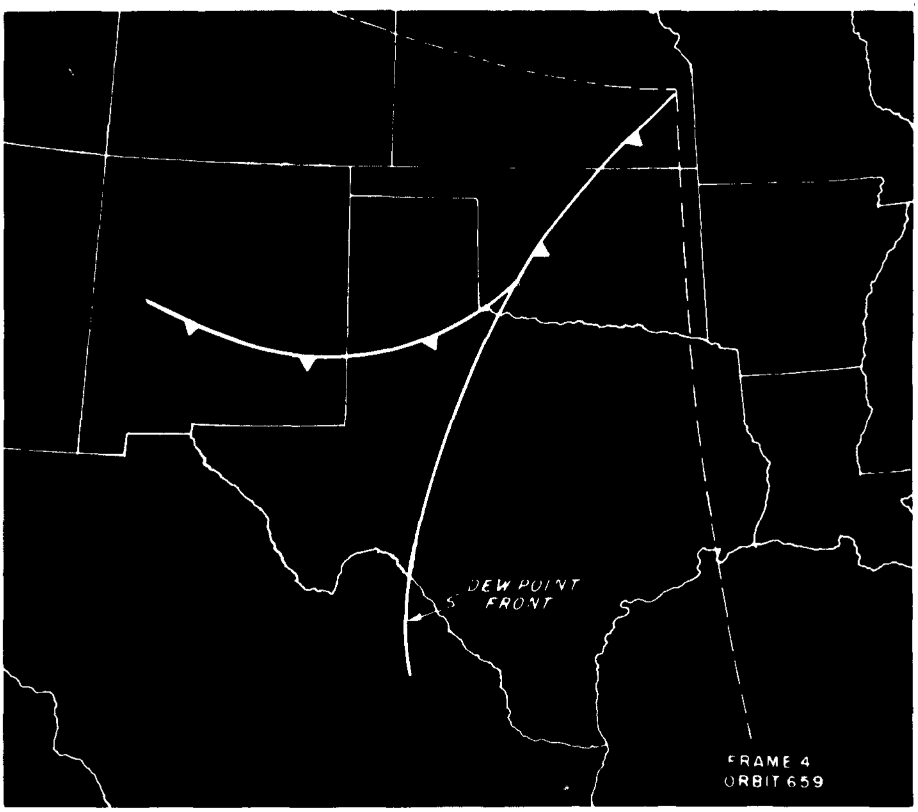


Figure 9a. -- Orbit 659, frame 4, 16 May 1960 at 2036Z.
Figure 9b. -- Surface fronts, 16 May 1960 at 2100Z, with rectified cloud patterns for 2036Z as shown by orbit 549, frame 4.

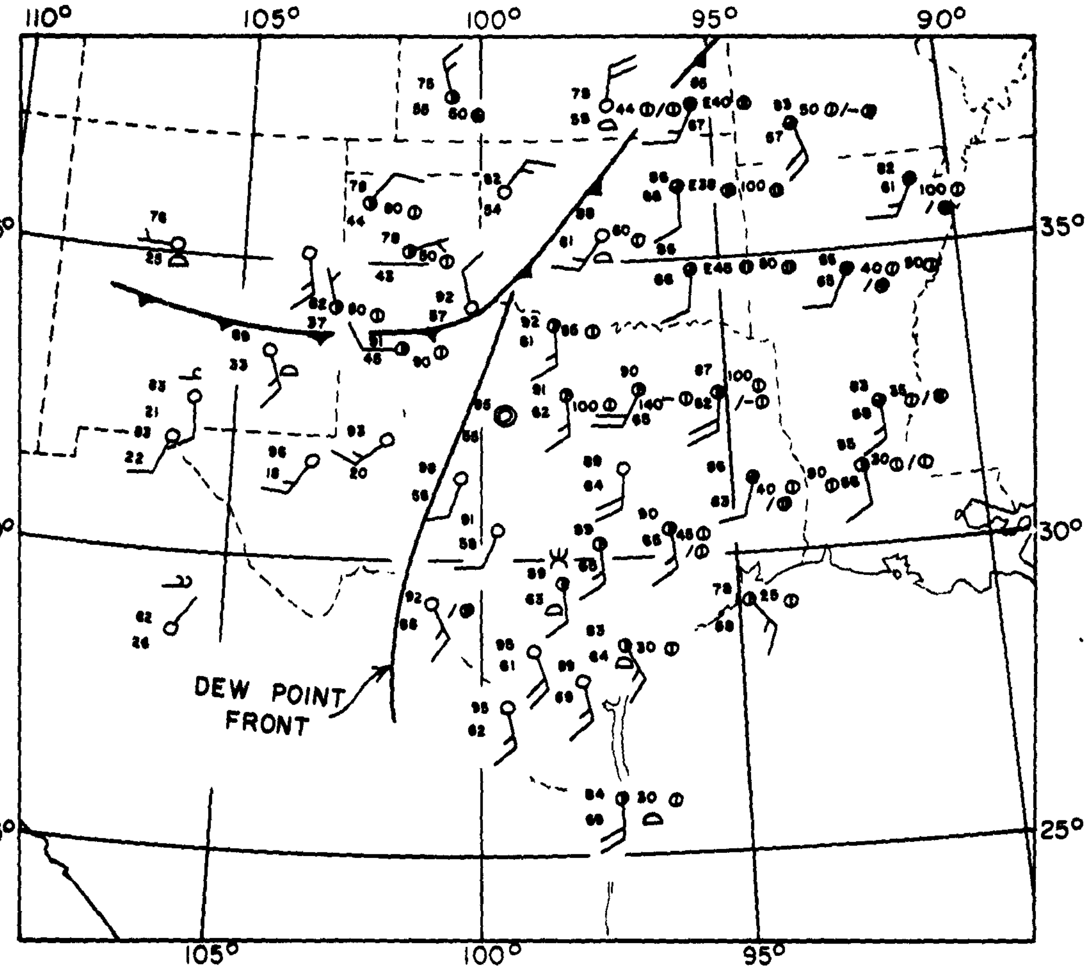


Figure 10.-- Selected surface data and frontal analysis, 16 May 1960 at 2100Z.

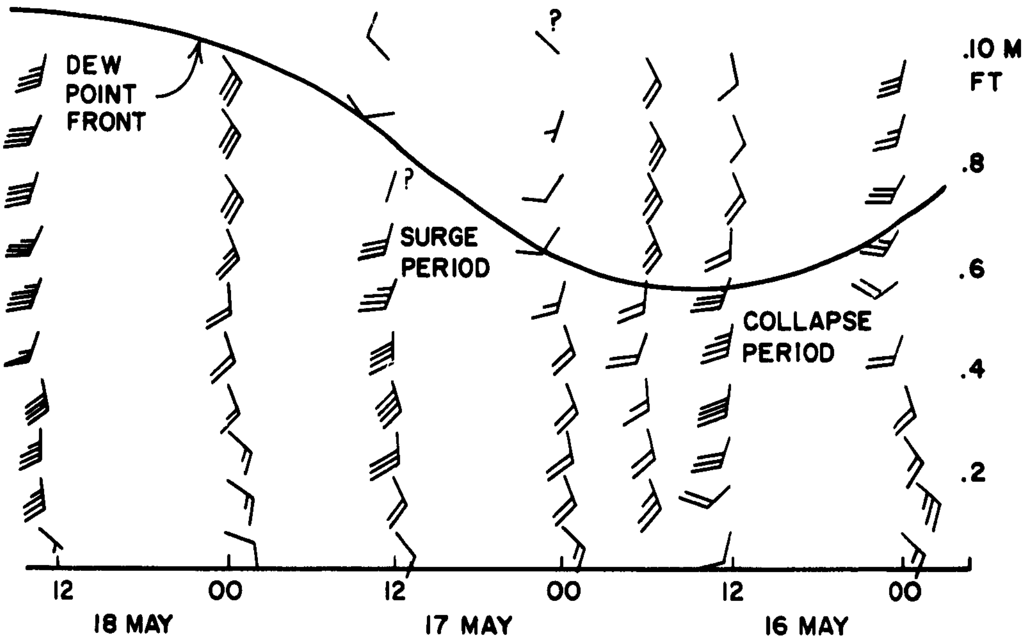


Figure 11. -- Time section of winds over San Antonio. The height of the dew point front is shown.

determined from temperature soundings. At the same time the dew point front pushed westward into New Mexico, as shown by Fig. 12. This westward push of the dew point front was accompanied by increases in dew point temperature into the high 50's and low 60's over western Texas except the extreme western tip. At the same time, the surface temperatures were cooler than they had been for days. The orographic lifting of the maritime air over the terrain combined probably also with convergence over western Texas released the instability in the maritime air and allowed the cloud formations to break through the frontal inversion. The cumulus activity developed rapidly, reaching the thunderstorm stage. A few tornadoes occurred in the Texas Panhandle.

An example illustrates the effect of the westward surge of tropical maritime air on its stability. The San Antonio sounding for 17 May 1960 at 1200Z can be considered as a representative initial state of the maritime air. This sounding is reported by the line AA in Fig. 13. The corresponding dew point curve is represented by line A'A'. If the air moves westward into West Texas and eastern New Mexico, it would be lifted by at least 2,500 ft. The corresponding graphical operation for the air over San Antonio results in a curve as shown by the line BB of Fig. 13. This change neglects convergence. The modified air is about the same temperature as the tropical continental air (compared with Figs. 6a and 6b or with the sounding curve CC in Fig. 13). Further, the air in undergoing the lifting has become saturated, thus releasing the conditional and convective instability initially present in the tropical maritime air.

On Orbit 673, the TIROS satellite photographed the Texas area about one hour before the record time of the data of Fig. 12. Fig. 14a is a copy of the resulting photograph while Fig. 14b is the rectified cloud diagram. The bright cloud masses in the middle of the picture represent the layers of strato-cumulus with embedded cumulus and cumulonimbus typical of the instability conditions released within the maritime air mass. The dew point front was just to the west of this dense cloud mass, as shown in Fig. 14b. The surrounding cloud masses were primarily cirrus or cirrostratus with scattered cumulus underneath. Erickson and Hubert (1961) have discussed in detail the interpretation of the cloud features shown in Fig. 14.

In summary, a surge of the maritime air mass into West Texas was accompanied by an outbreak of cumulus activity and possibly even the development of a squall line with heavy thunderstorms and tornadoes roughly parallel to the surface position of the dew point front. This particular cloud pattern could accompany other types of disturbances, for instance a polar front of the squall line nature, so does not appear to be an infallible indicator of the dew point front in the West Texas area.

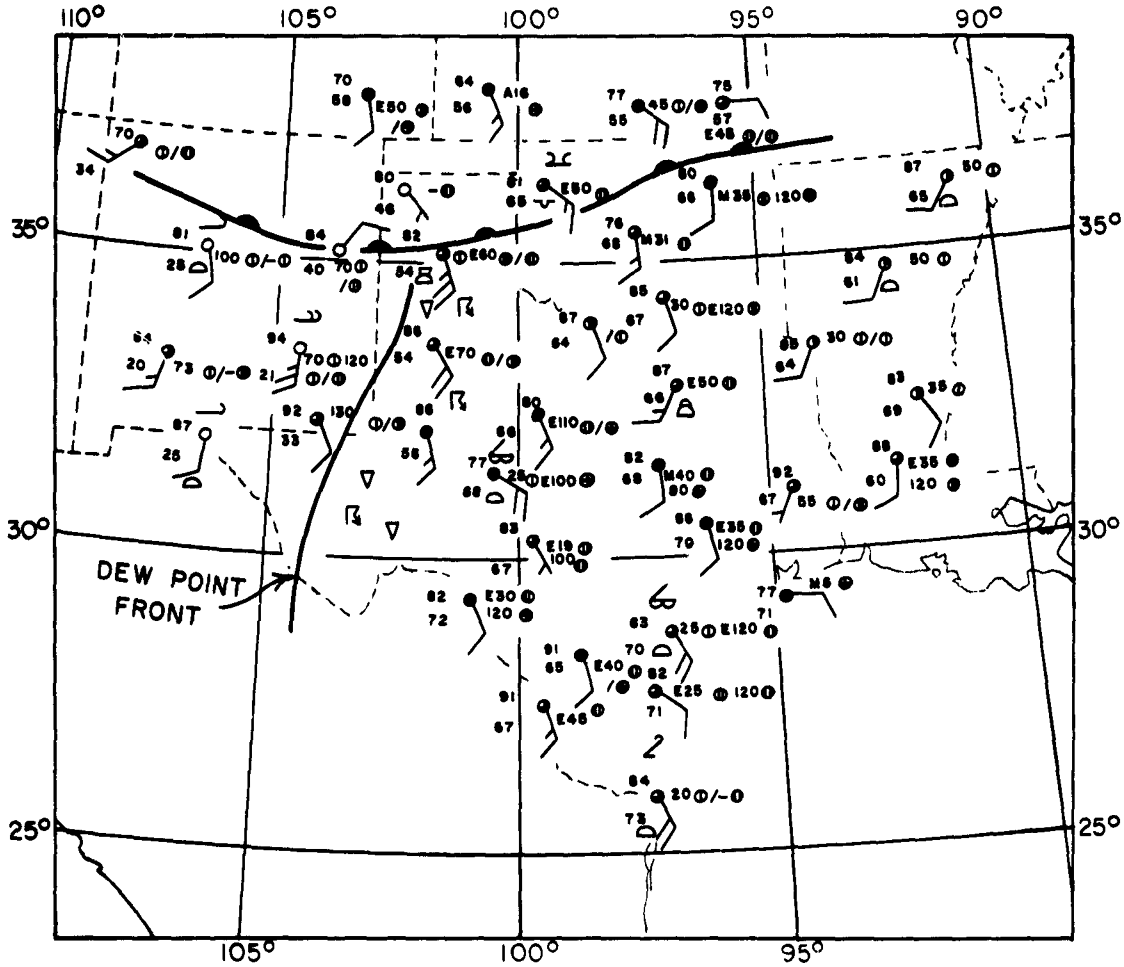


Figure 12.-- Selected surface data and frontal analysis, 17 May 1960 at 2100Z. The areas of showers and thunderstorms are indicated by appropriate symbols.

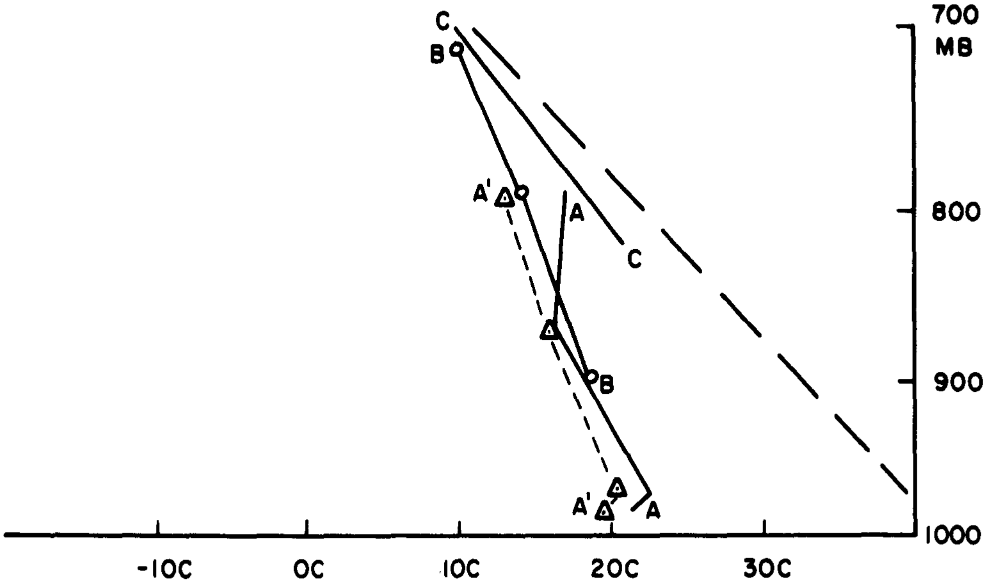
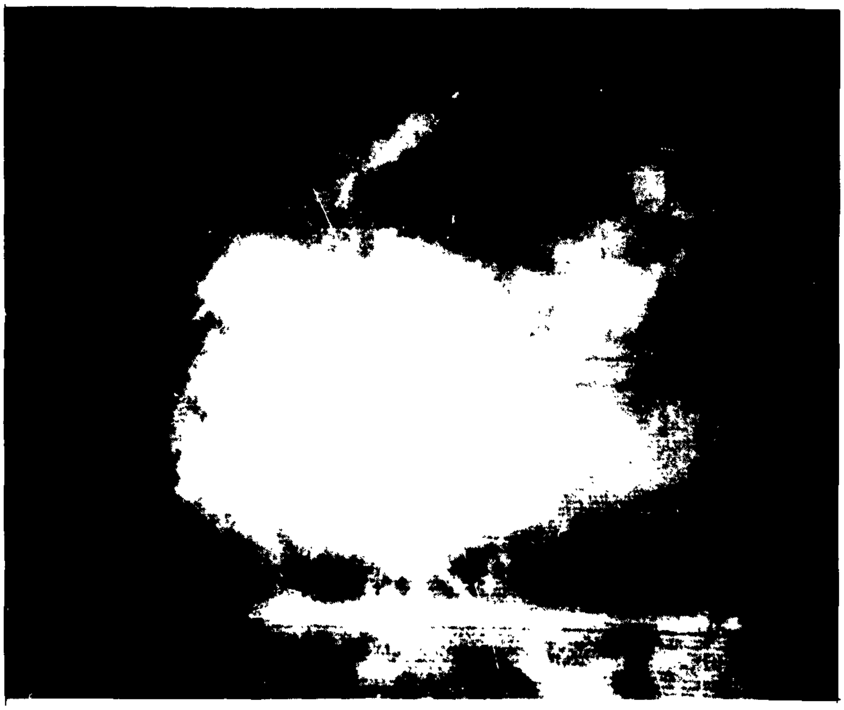


Figure 13. -- Temperature and dew point lapse rate for San Antonio, 17 May 1960 at 1200Z, shown by curve AA. Curve BB shows the same air after being lifted 2500 feet. Curve CC shows the temperature sounding for Midland, 17 May 1960 at 1200Z.



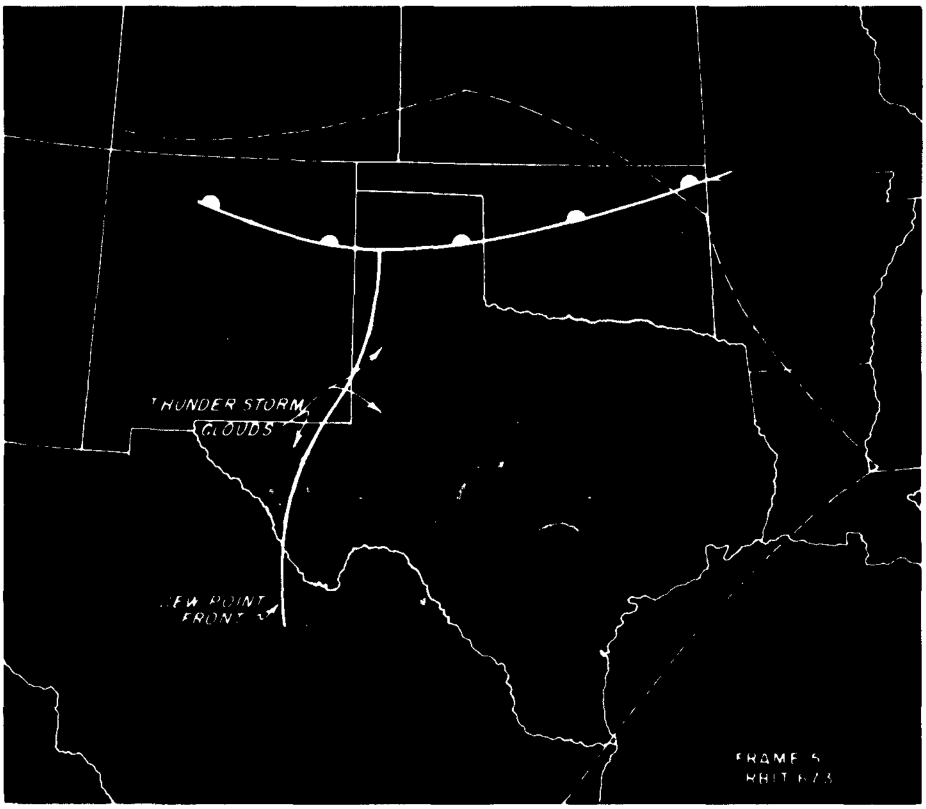


Figure 14a. -- Orbit 673, frame 5, 17 May 1960 at 2002Z.

Figure 14b. -- A rectified schematic diagram of the clouds pictured by orbit 673, frame 5, 17 May 1960 at 2100Z.

Case 5. --The dew point front is not in the area and the TIROS pictures do not show clouds suggesting a dew point front.

On 30 May 1960 the maritime air covered the entire area being studied. Continental air was not present and a dew point front could not be located. The pictures of Orbit 863, made at 2225Z on the 30th showed a random scattering of clouds throughout the area except for a well organized squall line in central Texas. The squall line appeared to be associated with a line of instability within the maritime air mass. No attempt is made to illustrate these features.

Other cases.

The other orbits listed in Table 1 do not appear to add more information concerning the nature of the cloud distribution associated with the dew point front. In all cases listed, the dew point front was easily found and in all cases the stratiform or stratocumulus clouds were present some small distance east of the surface position of the dew point front. A study of Orbit 702 has been presented elsewhere (Whitney and Fritz, 1961).

5. Conclusions.

The results of this study suggest that the TIROS meteorological satellite pictures are useful in identifying the presence of and the location of the dew point front. Table III summarizes the relationship between the occurrence of the dew point front on the maps and the indication of the dew point front in the satellite pictures. This table indicates ten cases when map and satellite pictures agree and two cases when the map and the picture are not in agreement. The skill score is 62.3. Of course, this is a small sample to handle statistically and such results are subject to change as more data are compiled. It is not probable, however, that any appreciable change in the significance of the results would be obtained. The TIROS data thus appear to aid in the identification of the location and activity of the dew point front.

It should be noted (see Table I) that for the cases studied the pictures were taken in the afternoon. From what is known of the nature of the typical morning stratus of the maritime air, it is believed the pictures taken in the morning would be even more effective in delineating the position of the dew point front. Also, in the morning there is less cumulus activity over the mountains to the west.

Table III. --A Contingency table - the occurrence of dew point fronts on maps and in TIROS pictures.

	Front on Map	Front not on Map	TOTALS
Pictures indicate front	7	1	8
Pictures do not indicate front	1	3	4
TOTALS	8	4	12

An objective of this study was to determine if the TIROS would give any additional information on the structure and behavior of the dew point front. Whether the information obtained in this study is new, of course, depends on one's previous information. However, several features of the structure and behavior of the dew point front are highlighted by the pictures. One feature is the clear area just east of the front, where the condensation level is higher than the inversion layer. The study also suggests that there is a pronounced difference in the nature of the cloud cover when the front is moving eastward and lowering as compared to when there is a surge westward of the maritime air. The eastward motion appears to be associated with almost complete disappearance of the clouds while the westward surge seems to be accompanied by intensified cloud activity and even thunderstorms and tornado activity. Further, the extent of the front into Mexico appears to be indicated in some of the pictures. The limited surface data in Mexico makes the front rather difficult to locate on the basis of conventional meteorological information.

The operational use of the meteorological satellite pictures to locate the dew point front appears limited at the present time. The primary reason for this is that there are few which actually picture the southwestern United States. However, the potential is great. When the coverage is sufficient and the time of orienting the pictures is reduced, an analyst can make great use of the meteorological satellite pictures for locating the dew point front, not only in Texas, but in Mexico as well.

In conclusion, the dew point front does frequently show up well in the meteorological satellite information. Such information, considered along with the surface and radiosonde data, can aid in producing a much better analysis for the southwestern United States. A better understanding of the dew point front along with a more satisfactory analysis should help to provide better forecasts of cloud cover and severe weather for New Mexico, Texas, and

Oklahoma, as well as for northern Mexico. With the advent of the NIMBUS and AEROS meteorological satellites the problem of area coverage should improve and the time required for orientation of the pictures should be greatly reduced. This should make the satellite information much more useful and reliable. In the meantime, a study similar to that reported here should be undertaken using the information obtained by the TIROS III, V, and VI satellites which provided pictures of much higher quality. These satellites were operational during the summer of 1961 and the summer and early fall of 1962, when the dew point front should have been even better developed than during the late spring of 1960. Such a study should provide a good check on the conclusions made in this paper.

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